UNOFFICIAL
PATENT
Docket No. 03-0418

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First named inventor: Maurice Peter Bianchi
Serial No. 10/806,710
Filing Date: June 23, 2004
Title: SOLAR CELL ASSEMBLY

Confirm. No. 2668
Art Unit: 1795
Examiner: Shannon Gardner

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DRAFT RESPONSE TO NON-FINAL OFFICE ACTION DATED JUNE 9, 2008

This response includes a section for amendments to the claims and a section for remarks.

Respectfully submitted,

~~/Hugh Gortler #33,890/~~
Hugh P. Gortler
Reg. No. 33,890
(949) 454-0898

Date: August 28, 2008

To: Examiner Gardner
Fax: 1-571-270-6270
Pages: 9

Thanks for your willingness to discuss this draft response. Please confirm receipt by indicating a time and date for a telephonic interview.
Thanks.

AMENDMENTS TO THE CLAIMS

1. (Currently amended) A multi-junction solar cell assembly comprising:

a transparent substrate;

a transparent conductive coating formed on the transparent substrate, said transparent conductive coating comprising gallium nitride to provide a defect-free surface for growing an InGaN solar cell;

a solar cell including a plurality of gallium indium nitride junction layers ~~formed~~ grown successively on the transparent conductive coating;

an indium nitride junction layer formed on the plurality of gallium indium nitride junction layers; and

a metallization layer formed on the indium nitride junction layer;

wherein each successive gallium indium nitride junction laver has a thickness greater than a thickness of the immediately preceding gallium indium nitride junction layer, each successive gallium indium nitride junction layer being directly adjacent the immediately preceding gallium indium nitride junction layer.

2. (Original) A multi junction solar cell assembly in accordance with claim 1 wherein the transparent substrate is selected from a group of transparent substrates consisting of sapphire, zinc oxide, and gallium nitride.

3. (Canceled).

4. (Currently amended) The solar cell assembly of claim 5, ~~A multi-junction solar cell assembly in accordance with claim 1~~ further comprising a gallium nitride junction layer formed on the transparent conductive coating between the transparent conductive coating and the plurality of gallium Indium nitride junction layers.

5. (Currently amended) The solar cell assembly of claim 24, ~~A multi-junction solar cell assembly in accordance with claim 1~~ wherein the solar cell includes a ~~each layer of the~~ plurality of gallium indium nitride junction layers [[has]] having a thickness of between about 0.2 microns and about 1.0 microns.

6. (Canceled).

7. (Currently amended) The ~~A multi-junction~~ solar cell assembly of claim 5, ~~in accordance with claim 1~~ wherein each layer of the plurality of gallium indium nitride junction layers has a gallium content of between about 90 wt % and about 10 wt % and an indium content of between about 90 wt % and about 10 wt %.

8. (Currently amended) The solar cell assembly of claim 5,~~A multi-junction solar cell assembly in accordance with claim 1,~~ further comprising at least three gallium indium nitride junction layers, wherein each successive layer of the plurality of gallium indium nitride junction layers has a gallium content less than the immediately preceding layer of the plurality of gallium indium nitride junction layers and an indium content greater than the immediately preceding layer of the plurality of gallium indium nitride junction layers.

9. (Currently amended) The solar cell assembly of claim 5, ~~A multi-junction solar cell assembly in accordance with claim 1~~ wherein each layer of the plurality of gallium indium nitride junction layers has a band gap of between about 0.7 eV and about 3.4 eV.

10. (Currently amended) The solar cell assembly of claim 5, ~~A multi-junction solar cell assembly in accordance with claim 1~~ wherein each successive layer of the plurality of gallium indium nitride junction layers has a band gap less than the band gap of the immediately preceding layer of the plurality of gallium indium nitride junction layers.

11. (Currently amended) The solar cell assembly of claim 24, ~~A multi-junction solar cell assembly in accordance with claim 1~~ wherein the transparent conductive coating comprises:

a nucleation layer formed on the sapphire cover~~transparent substrate~~;

a lateral epitaxial overgrowth layer of gallium nitride formed on the nucleation layer; and

a defect-free gallium nitride layer formed on the lateral epitaxial overgrowth layer.

12. (Currently amended) The ~~A multi-junction~~ solar cell assembly of ~~in accordance with~~ claim 11, wherein the nucleation layer comprises:

an aluminum nitride coating formed directly on the sapphire cover~~transparent substrate~~ in intimate contact with the sapphire cover~~transparent substrate~~; and

a seed layer of gallium nitride formed on the aluminum nitride coating.

13. (Currently amended) The ~~A multi-junction~~ solar cell assembly of claim 24, ~~in accordance with claim 1~~ wherein the transparent conductive coating comprises:

a plurality of alternating layers of gallium nitride and aluminum gallium nitride; and

a plurality of quantum wells, each quantum well of the plurality of quantum wells formed at a corresponding interface between adjacent layers of gallium nitride and aluminum gallium nitride of the plurality of alternating layers of gallium nitride and aluminum gallium nitride.

14. (Currently amended) The solar cell assembly of ~~A multi junction solar cell assembly in accordance with~~ claim 13 wherein a first gallium indium nitride junction layer of the plurality of gallium indium nitride junction layers is formed directly on a last gallium nitride layer of the plurality of alternating layers of gallium nitride and aluminum gallium nitride in intimate contact with the last gallium nitride layer of the plurality of alternating layers of gallium nitride and aluminum gallium nitride.

15. (Original) A multi junction solar cell assembly in accordance with claim 1 wherein the transparent conductive coating comprises a gallium nitride layer formed on the transparent substrate.

16. (Currently amended) The ~~A multi junction~~ solar cell assembly of claim 5, ~~in accordance with claim 1~~ further comprising a metal current collector bus for receiving electrical power collected from the plurality of gallium indium nitride junction layers by the transparent conductive coating.

17. (Cancelled)

18. (Cancelled)

19. (Currently amended) A method of forming a unitary multi junction solar cell assembly comprising ~~the steps of~~:

forming a transparent conductive coating including gallium nitride on a sapphire cover~~substrate~~; and

~~forming~~ growing a solar cell including a plurality of gallium indium nitride junction layers on the transparent conductive coating without taking any measures to correct for lattice mismatch. ~~, wherein each successive gallium indium nitride junction layer has a thickness greater than a thickness of the immediately preceding gallium indium nitride junction layer, each successive gallium indium nitride junction layer being directly adjacent the immediately preceding gallium indium nitride junction layer; and~~

~~forming a metallization layer on the plurality of gallium indium nitride junction layers, wherein the metallization layer is selected from a group that includes a layer of aluminum, a layer of chromium, and a layer of titanium.~~

20. (Currently amended) A method in accordance with claim 19 further comprising forming a metallization layer on the plurality of gallium indium nitride junction layers, wherein the metallization layer is selected from a group that includes a layer of aluminum, a layer of chromium, and a layer of titanium; and forming an Indium nitride junction layer on the plurality of gallium indium nitride junction layers between the metallization layer and the plurality of gallium indium nitride junction layers.

21. (Original) A method in accordance with claim 19 further comprising forming a gallium nitride junction layer on the transparent conductive coating between the transparent conductive coating and the plurality of gallium indium nitride junction layers.

22 ~~19.~~ (Cancelled)

23 ~~20.~~ (Cancelled)

24 ~~21.~~ (New) A solar cell assembly comprising:

a sapphire cover;

a GaN transparent conductive coating (TCC) as front collector, the GaN TCC formed on the sapphire cover; and

a multjunction InGaN solar cell grown on the GaN junction layer;

wherein the GaN TCC provides a defect-free surface upon which the InGaN solar cell is grown.

REMARKS

Claims 1-2, 4-5, and 7-23 are pending.
Claims 1-2, 4-5, and 7-23 are rejected.

In the office action dated June 9, 2008, claims 1-2, 4-5, 7-12 15-18 and 22 are rejected under 35 USC §103(a) as being unpatentable over Bour EP 977,279 in view of a paper by Wu et al. entitled "Superior radiation resistance in InGaN alloys"), and Schetzina U.S. Patent No. 5,679,965; claims 19-21 are rejected under 35 USC §103(a) as being unpatentable over Bour in view of Wu, Nishii U.S. Publication No. 20030205721 and Schetzina; and claim 23 is rejected under 35 USC §103(a) as being unpatentable over Bour in view of Wu and Schetzina. Claims 1, 19, 22 and 23 are base claims.

New claim 24 recites a solar cell assembly comprising:

a sapphire cover;
a GaN transparent conductive coating (TCC) as front collector, the GaN TCC formed on the sapphire cover; and
a multjunction InGaN solar cell grown on the GaN junction layer;
wherein the GaN TCC provides a defect-free surface upon which the InGaN solar cell is grown.

The applicant has found that the front collector of GaN TCC on a sapphire cover produces a defect-free surface for growing a multijunction InGaN solar cell. There is no lattice mismatch with the InGaN solar cell. This is an unexpected result, which is clearly recited in new claim 24.

The unexpected result provides benefits. It allows the InGaN solar cell to be grown on the TCC/sapphire cover, thus forming a unitary assembly. No adhesive is needed to attach the cover to the solar cell (which has its own problems). No modifications to the solar cell have to be made to grow it on a cover.

The documents made of record do not teach or suggest this unexpected result. Wu et al. is silent about covers for their InGaN solar cell. They are also silent about lattice mismatches with substrates upon which their solar cell is grown.

Wu et al. mention problems with high-energy particle damage to InGaN solar cells, but offer no solutions. Wu et al. point out that "Work on InGaN has not yet progressed to the point of making complete devices, so we have chosen to study here basic material properties" (p. 6478, left column)

Of the Wu paper and the patents to Bour and Schetzina, only the Wu paper provided evidence of InGaN solar cells. Bour[1] and Schetzina[2] relate to laser diodes.

Moreover, Bour and Schetzina are cited to show work in solving lattice mismatches. However, as the applicant has found, such work is not necessary for the combination of the sapphire cover/GaN TCC/InGaN solar cell. The documents cited by the examiner simply provide evidence that the result is unexpected.

For these reasons, new claim 24 should be allowed over the documents made of record. So too should claims 4-5, 7-14 and 16, which have been amended to depend from new claim 24. Claims 17-18 and 22- 23 have been cancelled.

Claim 19 has been amended to recite a method of forming a unitary multi junction solar cell assembly. The method includes forming a transparent conductive

---

[1] Bour discloses a laser diode having a sapphire substrate 305, a thin amorphous buffer layer 310 of GaN, and thick and active InGaN layers 320 and 330. The buffer layer 310 serves as a nucleation layer. Paragraph 28 says the thick layer 320 allows higher indium content to be used in the active layer 330. Growing the active layer330 on the thick layer 320 results in less lattice mismatch than growing the active layer 330 directly on the GaN buffer layer 310.

[2] Schetzina discloses a semiconductor surface emitting laser having a lattice matched structure including a sapphire substrate, and a GaN layer, graded AlGaN layers and InGaN active layer. A multiple quantum well may be used instead of the graded layers of AlGaN.

coating including gallium nitride on a sapphire cover; and growing a solar cell including a plurality of gallium indium nitride junction layers on the transparent conductive coating without taking any measures to correct for lattice mismatch. Amended claim 19 and its dependent claims 20-21 should be allowed over the combination of Bour, Wu and Schetzina for the reasons above.

Claim 1 has been amended. Amended claim 1 and its dependent claims 2 and 15 should be allowed for the reasons above.